

# Tevatron Optics Correction at Low Beta

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Run II meeting  
*May 20, 2004*  
*Fermilab*

## *Talk outline*

1. Introduction
2. Ideas for optics correction
3. Results

## Introduction

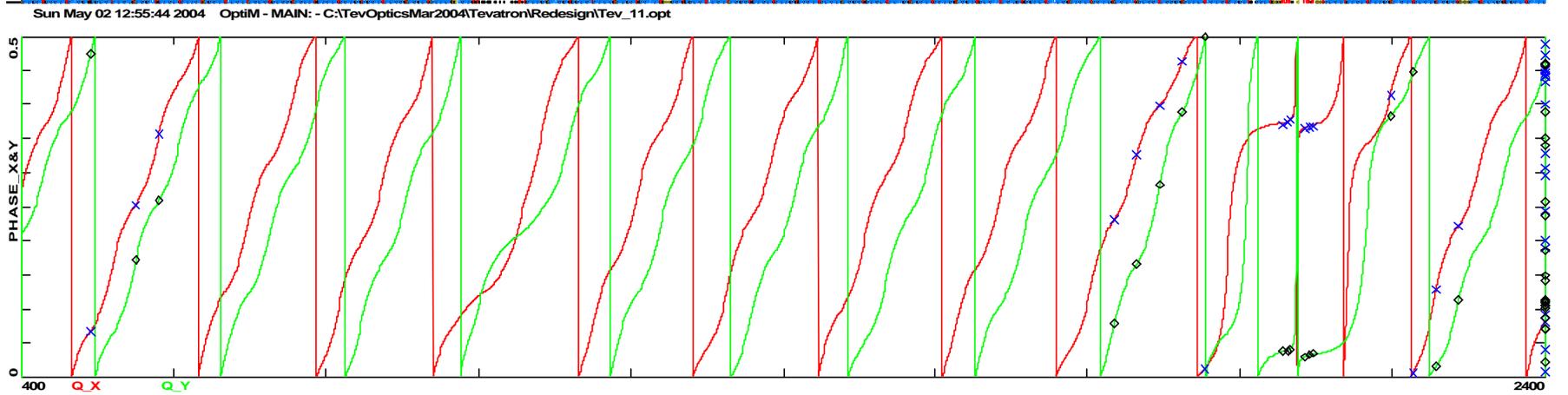
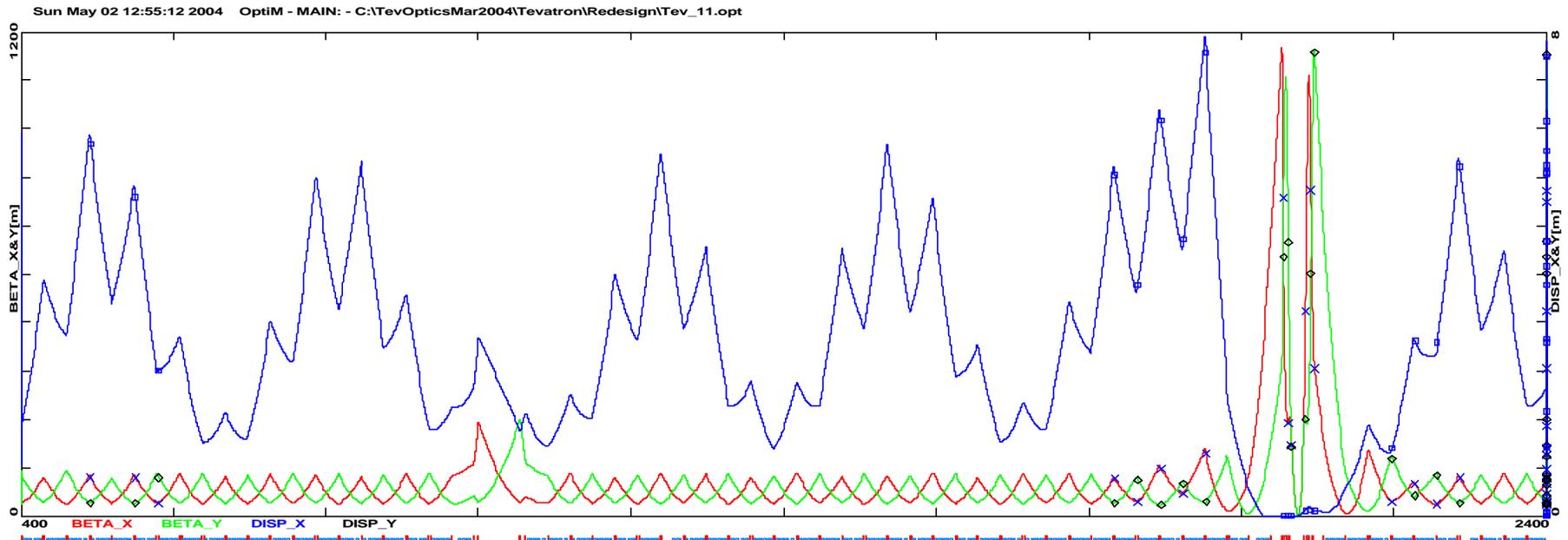
- ◆ First attempt for optics correction at Low beta, April 16, 2004
  - It was not successful for a number of reasons
    - In distinguish from the injection optics two defocusing quads chosen for vertical beam envelope correction were at the same phase
    - Dispersion would be affected by optics correction
    - Too large quad changes would be required because chosen knobs are not very effective
- ◆ Second successful attempt was performed at May 4, 2004
  - Differential model predicts beta-functions with accuracy not better than 10-15%
    - That implies that simultaneous optics correction in arcs and IPs is presently not feasible
  - Ideas
    - Correct beta-functions in IPs and minimize beta-function beating in arcs
    - Orthogonal knobs for beam envelope correction without affect the on horizontal dispersion
    - Orthogonal quads for measurements
    - Simultaneous measurements for helix correction have to taken

## *Introduction (continue)*

- ◆ End of store study to introduce new optics, May 12, 2004
  - Luminosity growth ~7-10% during old to new optics transition
  - Helix correction brought ~1-2% luminosity growth
  - Alpha bumps were exercised, ~1% luminosity growth, not implemented yet
    - Can improve beam-beam effects
- ◆ 2 week struggle to get tunes right
  - Further improvements of beam life time are expected (tune, chromaticity)
- ◆ Attempt to measure optics in sectors at May 18 was screwed up by strong coupling
  - Need to repeat the exercise

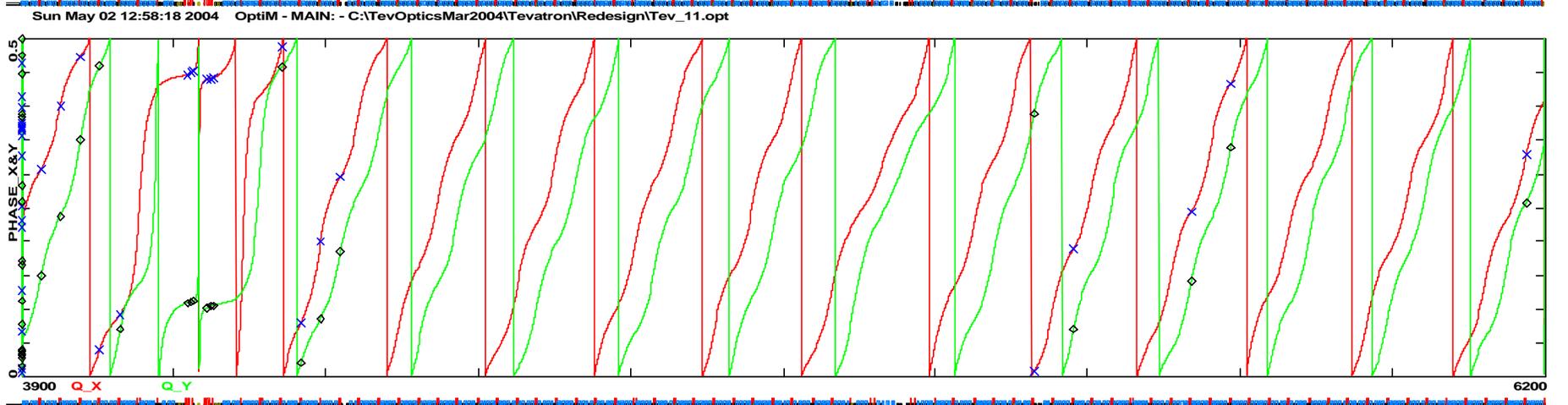
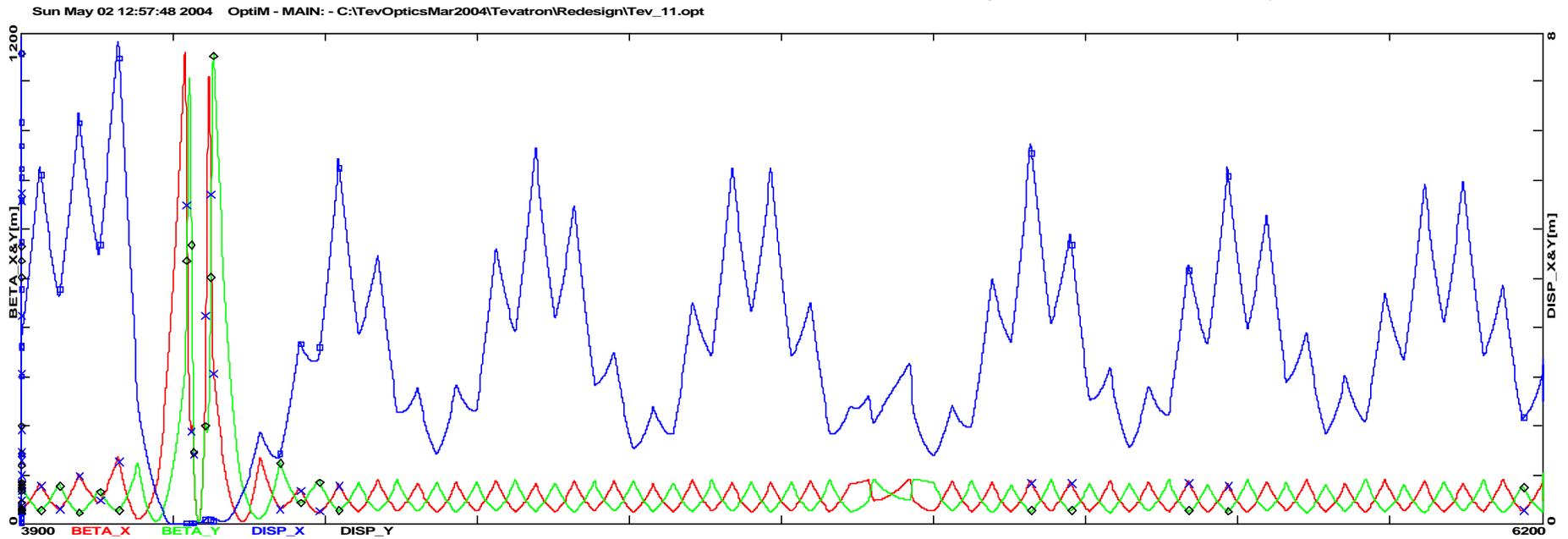
# Optics correction

Beta-functions and betatron phase advances for single power supply quads (F - B)



QF28 QF32 QF33 QA42 AQ0 AQ9 QA45 AQ7 B0Q2F - B0Q2D BQ7 QB15 BQ9 BQ0

# Beta-functions and betatron phase advances for single power supply quads (B - E)



QC42 CQ0 CQ9 QC45 CQ7 D0Q2F-D0Q2D CDQ7 QD15 DQ9 DQ0 QE17 QE19 QE26 QE28 QE47

## Quads for optics correction

### X- envelope (2 “orthogonal” knobs)

QA42 & DQ0 ( $I_{DQ0} = 3.5 * I_{QA42}$  to prevent excitation of vertical dispersion)

D0Q3T

### Y-envelope (2 “orthogonal” knobs)

D0Q2T

DQ7

### Horizontal dispersion correction

C:AQ7 and C:CQ7

**Values of quadrupole power supplies: design, before correction, proposed correction and final values as May 20, 2004, P=979.529 GeV/c.**

Name	Design, [A]	Before corr. [A]	Difference, P-A, [A]	Proposed corr.[A]	Proposed value [A]	Final [A]
B0 and D0 quads						
T:QA42	-44.23	-44.24	-0.01	-1	-45.23	-46.85
C:AQ0	104.78	100.72	-4.06			
C:AQ9	577.41	555.56	-21.85			
T:QA45		0.00	0.00			
C:AQ7	630.53	607.44	-23.09	-5	602.44	602.6
C:B0Q6	3675.34	3647.38	-27.95			
C:B0QT6	-22.90	-22.90	-0.01			
C:B0Q5	1981.01	1972.50	-8.51			
C:B0Q2	4721.28	4721.76	0.47	-4.5	4717.26	4716.49
C:B0QT2	-10.10	0.00	10.10			
C:B0Q3	4671.28	4666.29	-4.99	-4.5	4661.79	4660.18
C:B0QT3	-6.63	3.87	10.50			
C:BQ7	703.16	680.08	-23.07			
T:QB15	-44.23	-44.24	-0.01			
C:BQ9	497.68	479.72	-17.96			
C:BQ0	51.60	49.82	-1.78			
T:QC42	-44.23	-44.24	-0.01			
C:CQ0	104.24	100.72	-3.51			
C:CQ9	572.69	555.56	-17.13			
T:QC45		0.00	0.00			
C:CQ7	630.44	607.44	-23.00	-7	600.44	680.08

C:D0Q6	3716.35	3647.38	-68.96			
C:D0QT6	-22.90	-22.90	-0.01			
C:D0Q5	1984.05	1972.50	-11.54			
C:D0Q2	4715.79	4711.07	-4.71			
C:D0QT2	-3.40	19.60	23.00			
C:D0Q3	4649.12	4636.99	-12.12			
C:D0QT3	2.06	24.06	22.00	-2.7	19.3	21.30
C:DQ7	705.40	680.08	-25.31	-46		
T:QD15	-44.23	-44.24	-0.01			
C:DQ9	497.24	479.72	-17.53			
				3.5*QA42		
C:DQ0	51.78	49.82	-1.96	=-3.5	46.32	46.28
Trim quads						
T:QFA4	-12.02	-14.18	-2.16			
T:QDD1	7.62	10.50	2.88			
T:QFE1	-13.09	-14.64	-1.56			
T:QDE2	-7.56	-5.06	2.50			
T:QFF3	-6.21	-6.70	-0.49			
T:QDF4	12.41	15.38	2.97			
T:QE17	-13.09	-14.64	-1.56			
T:QE19	-22.90	-13.00	9.90			
T:QE26	0.13	-5.71	-5.84			
T:QE28	1.69	-1.22	-2.90			
T:QF28	4.07	-10.32	-14.39			
T:QF32	-18.53	-24.58	-6.05			
T:QE47	-1.31	3.71	5.02			
T:QF33	-0.58	-0.21	0.37			

## Optics measurements

### Small redundancy in the measurements:

- ◆ Final focus beta-function measurements
  - B0Q2, B0Q3, D0Q2, D0Q3
- ◆ Suppression of beta-function beating in arcs for “sin” wave
  - QX\_E26, QY\_E47

### Measurement procedure

- ◆ Data are acquired manually
- ◆ SVD is used to predict correction on-line

Reference  
measurements

	DI [A]	Qx0	Qx	DQx	Qy0	Qy	Dqy
B0Q2	10	0.5851	0.5939	0.0088	0.5751	0.5838	0.0087
B0Q3	4	0.5851	0.5916	0.0065	0.5753	0.5831	0.0078
D0Q2	10	0.5852	0.5939	0.0087	0.5754	0.5842	0.0088
D0Q3	4	0.5852	0.5923	0.0071	0.5754	0.5834	0.0080
QE26	25	0.5854	0.5944	0.0090	0.5755	0.5738	-0.0017
QE47	25	0.5855	0.5881	0.0026	0.5755	0.5669	-0.0086

## Results of the optics correction

### Beta-functions at B0 IP (CDF)

	$\beta_{xIP}$ [cm]	$\beta_{yIP}$ [cm]
Before correction at proton helix	48.7±5	45.0±2
After correction at proton helix	36.3±3	36.1±1
Central orbit after correction	35.3±3	40.4±2

### Beta-functions at D0 IP (CDF)

	$\beta_{xIP}$ [cm]	$\beta_{yIP}$ [cm]
Before correction at proton helix	47.1±3	44.2±1
After correction at proton helix	35.5±1	37.7±1
Central orbit after correction	35.7±1	41.3±1

## Beta functions in arcs

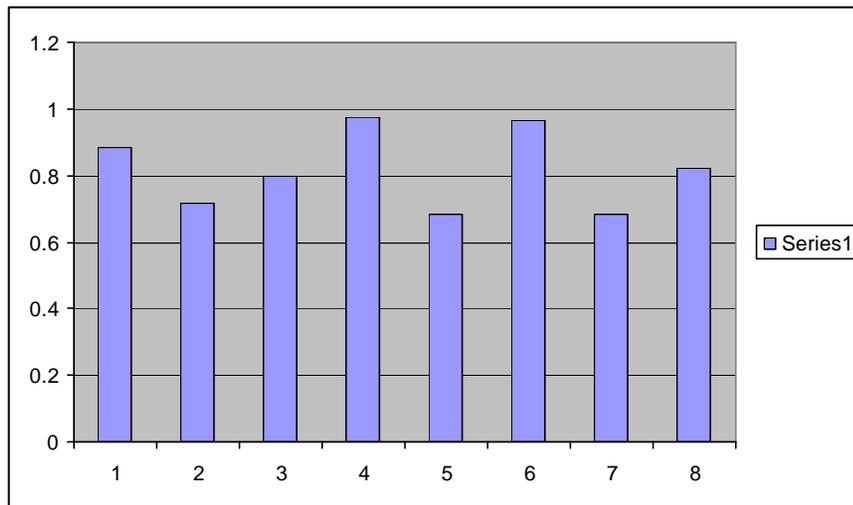
Before correction at proton helix

	BetaX/BetaX0	BetaY/BetaY0
QE26 (F)	1.06	0.6 ?
QE47 (D)	0.94 ?	1.01

After correction at proton helix

	BetaX/BetaX0	BetaY/BetaY0
QE26 (F)	0.76	0.72 ?
QE47 (D)	1.05 ?	0.77

## May 18 measurements in sectors

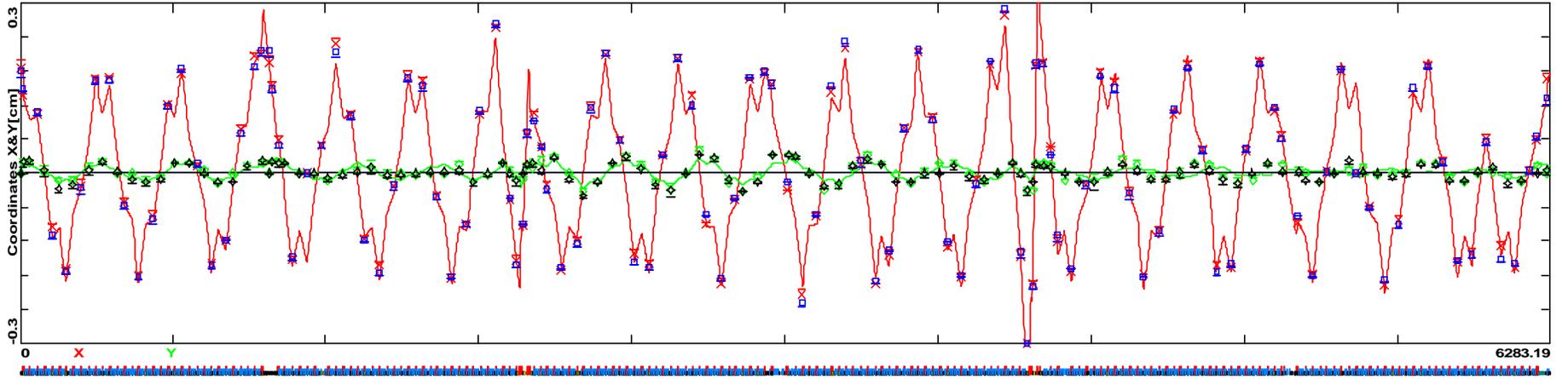


Relative beta-functions  
at trim quads\*

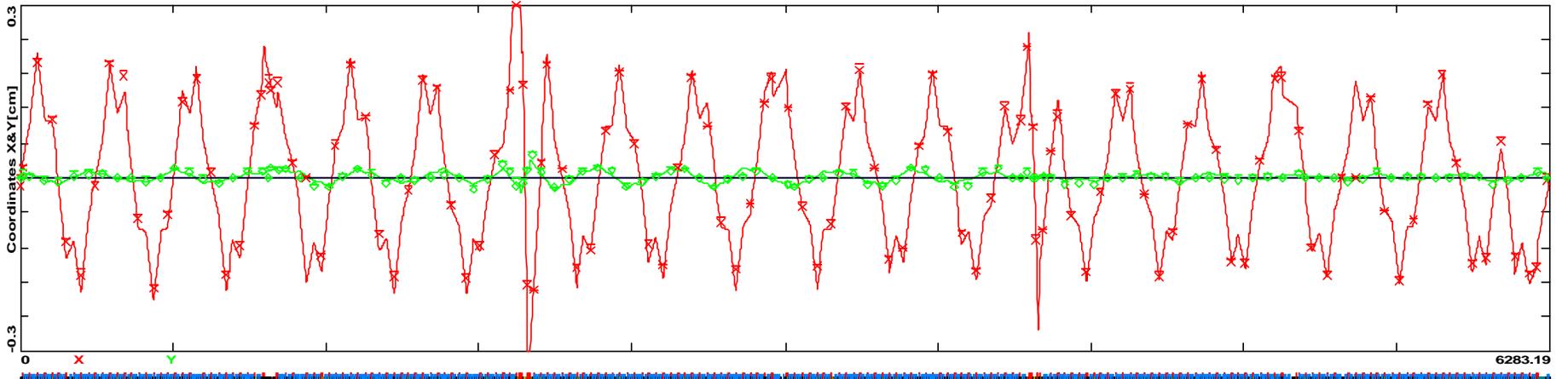
T:QE17	75
T:QE19	61
T:QE26	68
T:QE28	83
T:QF28	58
T:QF32	82
T:QE47	58
T:QF33	70

\* Design response with  
no coupling is ~ 85 units

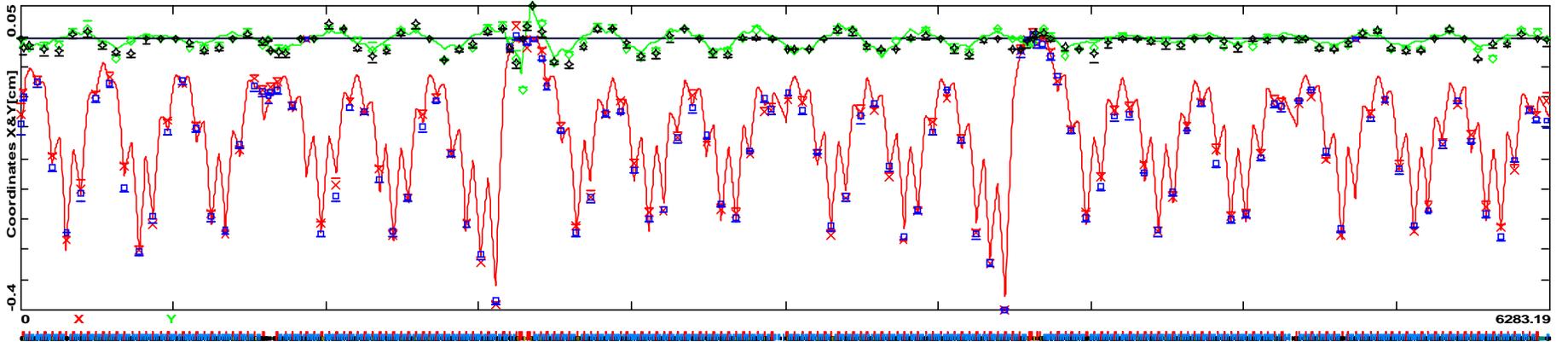
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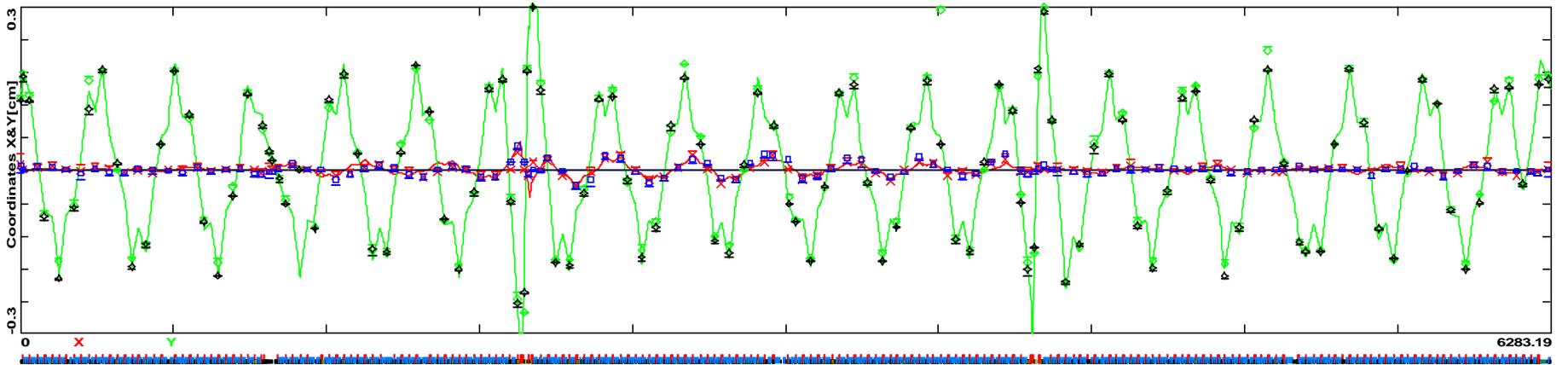
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